TO COMPARE THE INCIDENCE OF WOUND GAPING IN "NO KNOT" SUBCUTICULAR TECHNIQUE VERSUS STANDARD SUBCUTICULAR TECHNIQUE IN ELECTIVE SURGERIES

Dissertation submitted in partial fulfillment of regulation for the award of M.S. Degree in General Surgery

(Branch I)

THE TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

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March - 2010

CERTIFICATE

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DECLARATION

I solemnly declare that the dissertation titled **"TO COMPARE THE INCIDENCE OF WOUND GAPING IN "NO KNOT" SUBCUTICULAR TECHNIQUE VERSUS STANDARD SUBCUTICULARTECHNIQUE IN ELECTIVE SURGERIES "** was done by me from 2007 onwards under the guidance and supervision of **Professor Dr. P.GOVINDRAJ Mch &** **Professor Dr. R. PERUMAL RAJAN (Retd).**

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ACKNOWLEDGEMENT

*First I thank **Lord Ganesh,** for showering his blessings on me and making me determined and dedicated to complete this venture in a successful manner.*

*I express my gratitude to **Dr. V. Kumaran,** the **Dean,** Coimbatore Medical College Hospital for providing facilities to carry out this project work successfully.*

*I sincerely thank **Prof Dr. P. Govindaraj Mch., Professor and HOD, Department of General Surgery** for his constant guidance and encouragement through out the period of this study.*

*I would like to express my gratitude to my Guide **Dr. TAMIL SELVAN M.S.** for his valuable guidance and support without which this project work would not have been possible.*

*I am extremely thankful to **Prof. Dr. A. Ramamoorthy, Prof Dr. G. Mohan, Prof. Dr. sP.M. Nanjundappan,** for their constant encouragement and support to carry out this study.*

*I would like to thank **Prof Dr. R. Perumal Rajan (Retd)** for his support and suggestion during the study.*

*I would like to give special thanks to **Dr .Chidambara jothi,***

***Dr. T. Srinivasan, Dr. A. Nirmala, Dr. Muthulakhmi,** and all other **Assistant Professors of the Department of Surgery**, **CMC Hospital**, for their voluntary and useful guidance and support.*

I thank my seniors and colleagues who have been a source of constant help. I also thank Mr. P. Muthukrishnan for the excellent presentation of this dissertation.

Last but not the least, I would be failing in my duty if I don't thank my ***patients*** *and our ward nursing staff and theater staff without whose co-operation this study would not have been completed.*

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LIST OF ABBREVIATIONS

ECM	**-**	**Extra cellular matrix**
EGF	**-**	**Epidermal growth factor**
FGF_S	**-**	**Fibroblast growth factors**
G-CSF	**-**	**Granulocyte – colony stimulating factor**
GM – CSF	**-**	**Granulocyte macrophage – colony stimulating factor**
PDGF	**-**	**Platelet derived growth factor**
HGF	**-**	**Hepatocyte growth factor**
IGF – 1	**-**	**Insulin – like growth factor**
IL -1	**-**	**Interleukin 1**
KGF's	**-**	**Keratinocyte growth factors**
TGF – β	**-**	**Transforming growth factor β**
TGF – α	**-**	**Transforming growth factor α**
TNF	**-**	**Tumor necrosis factor**
VEGF	**-**	**Vascular endothelial growth factor**

ABSTRACT

Background and objectives

"Never judge until you have seen him closing the wound" is a saying attributable to lord Moynihan. The ideal wound closure techniques is one that produces maximal wound eversion, is technically simple to perform, maintains tensile strength throughout the healing process, allows for precise wound edge approximation and does not leave suture marks .This was feasible with the advent of subcuticular sutures, initially by Knot technique, the persistence of wound gaping has led to the development of No Knot subcuticular technique.

OBJECTIVES:

To evaluate the incidence of wound gaping in "Knot" / "No Knot" technique .To compare the incidence of infection, to compare cosmetic outcome and duration of hospital stay.

Methodology

In our study 50 patients underwent clean abdominal surgeries (appendisectomy, hernia repair, thyroidectomy and lipoma excision) which were selected for subcuticular suturing**. Out of 50, 25 underwent closure of skin with "No Knot" subcuticular technique while the remaining 25 had their skin closed with standard "Knot" technique. The comparison of the two group was done in relation to post operative wound complications, cosmetic outcome and hospital stay.**

Results

In the knot group, 4 patients (12%) had post operative infection in the form of purulent discharge on 5th POD. 5 patients (20%) developed wound gaping. In the no knot group, 3 patients (12%) developed wound infections and only 2 patients (8%) developed wound gaping. On calculating P value, it came as insignificant. The 'No Knot' group had lesser number of wound gapings as compared to knot group, but it was statistically insignificant (P = 0.052). Patients were cosmetically evaluated at I month post operative, 4 patients were lost to follow up. Average Visual Analogue Score [VAS] of patients in knot group was 64.6 and 71.6 in no knot group. Average Hollander Wound Evaluation Score [HWES] of patients in knot group was 4.32 and 5.02 in no knot group. P value was highly significant in both the scores.

Conclusion and Interpretation

Incidence of post operative wound infection was slightly less in the no knot group. Incidence of wound gaping was less in no knot group but was statistically insignificant. The No knot group provided a better cosmesis than the other group.

Key words

No Knot, subcuticular technique, cosmesis, wound gap.

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INTRODUCTION

In modern times, with the advent of elective surgery, more energy has been directed at achieving an efficient and uncomplicated healing of the deliberately inflicted wound. “Never judge until you have seen him closing the wound” is a saying attributable to lord Moynihan. The surgical scar remains the only visible evidence of the surgeon’s skill and not infrequently, all of his efforts are judged on its final appearance.

Co option of wound surface is necessary for primary wound healing. The ideal wound closure techniques is ones that produces maximal wound eversion, is technically simple to perform, maintains tensile strength throughout the healing process, allows for precise wound edge approximation and does not leave suture marks.

In most situations sutures are required to obtain such approximation. The primary function of a suture is to maintain wound closure and promote wound healing when the integrity of the wound is most vulnerable. Principles of wound closure focus on relieving tension on the wound and bringing the skin edges together in an everted orientation.

Sub cuticular continuous is a very practical and useful method of skin closure. Traditional methods of putting subcuticular stitches involves formation of anchoring knots at both the ends leading to tissue reaction impairing optimal wound healing.

Newer techniques have been described for the placement of completion knots following subcuticular sutures. But the persistence of wound gaping and a continuous search for a cosmetically better scar has led to the development of “NO KNOT” sub cuticular results in the from of lesser wound gaping and better cosmetic scar.

OBJECTIVES

The objectives of the present study are;

1. **Evaluate incidence of wound gaping in the "KNOT" / "No knot" technique.**
2. **To compare the incidence of infection in two techniques**
3. **To compare the cosmetic outcome**
4. **Duration of hospital stay.**

REVIEW OF LITERATURE

HISTORICAL ASPECTS

A suture is strand of material used to tie or ligate blood vessels and to sew (approximate) tissue together. To suture is the act of sewing or bringing together.

The earliest recording of a 'wound healing man' is in a cave drawing in Spain dating back some 20-30,000 years. This is one of the first recordings of wounds from the stone age. From the earliest recorded history it is clear that the Assyrians knew about healing, not just from an observational point of view but also in terms of practical management.

The ancient Egyptians were the first civilization to have trained physicians to treat physical aliments. Medical papyri, such as the Edwin smith papyrus (circa 1600 BC) and the Eders papyrus (circa 1534 BC), provided detailed information of management of disease, including wound management with the application of various potions and grease to assist healing (breasted, 1930; Bryan, 1930).

Soon after the Egyptians came, the Indian knowledge as professed by Sushurta samhita. The sushruta scripts also include a description of how insects have been applied in the healing of wounds. The earliest type of clip was based on the mandibles of certain ants. It describes how wounds in connection with the bowels caused so much juice that they were difficult to close.

The mandibles form a certain 'solider ant' were used to close these types of wounds. This technique is also found, in Asia, Africa and South America. The mandible from the Eciton burchell are particularly large. Its mandibles wound close on the wound and the body would then be pinched off (fig I). contemporary clips work according to the same principles but the 'ant – method' is still practiced by some south American tribes.

The edges were approximated and black ants were applied, to the wound. As soon as their mandibles closed on the two edges of wound the ant's heads were snipped off and left in situ.

The concept of wound healing remained a mystery, as highlighted by the famous saying by Ambroise Pare (French military surgeon, 1510-1590), " I dressed the wound. God healed it" (Cohen, 1998)

The father of medicine, Hippocrates, who lived nearly 2500 years age, wrote several accounts on wound healing and was aware of the importance of infection in relation to wound healing. He understood the concepts of primary and secondary wound healing, using antiseptics such as wine. In only a few hours, wine can eliminate certain types of bacteria such as Cholera Vibrios. E.typhi, S.aures and E.coli.

S

Celsus wrote about suture in the treatise de medicine, describing the suture of the soft tissue with the human hair. He also described small metal clips similar to Micheal clips of today.

In order to understand the wound healing process, it is necessary to understand the medical patho – physiology.

BIOLOGY OF WOUND HEALING

Wound healing, the body's response to tissue injury, is an essential and primitive process common to all multicellular organisms where in a principal type of cell assumes embryonic features, undergoes migration, divides and then differentiates to produce and extracellular matrix in a seemingly less that optimal or hostile environment.

TYPE OF HEALING

1. Primary intention

Most heal by primary intention, where the wound edges are brought together (apposed) and then held in place by mechanical means shortly after injury (adhesive strips, staples or sutures), allowing the wound time to heal and develop enough strength to withstand stress without support.

It is also the way must surgical wounds heal. Typically such wound are created in aseptic conditions with minimal bacterial contamination and a minor amount of tissue damage. They have accurately apposed and sutured wound edges. Epithelializiaon and contraction have little role in this type of healing.

Secondary Intention

Healing by secondary intention happens when the wound is left open, because of the presence of infection, excessive trauma or skin loss, and the wound edges come together naturally by means of granulation and contraction.

There are 3 main reasons why wound will undergo this form of healing: wound infection, substantial tissue damage or lack of skin edge apposition. This form of repair is also encountered following ulceration, abscess formation, major superficial wounds or tissue infarction. Healing by secondary intention allows the natural processes to occur without surgical closure. Wound contraction is the most important factor that aids secondary healing.

Tertiary Intention or Delayed primary closure

Often performed in contaminated wounds, does not retard wound strength. Thus delayed closure may decrease wound morbidity without impairing wound strength.

Phase of wound healing

It is generally agreed that there are essentially 3 phase of wound healing.

Lag phase / Inflammatory or Exudative phase

- **Inflammation of wound and mobilization of the cells which will synthesize granulation tissue.**

- **Lag phase was so entitled not because it is a phase of inactivity in wound repair, but simply because there is no significant increase in the mechanical strength of the wound.**

Proliferative or granulation phase

- Granulation tissue is formed in the wound; collagen and mucopolysaccharides are synthesized by the granulation tissue, and there is and increase in the mechanical strength of the wound.

Wound contraction (matrix formation) or Remodeling phase

- Cells in the wound diminish in number but there is extensive remodeling of wound collagen and further increase in the mechanical strength of the wound.

Inflammation / Exudative phase (2-5 days)

It begins immediately upon injury and lasts for several days. Tissue injury causes disruption of blood vessels and extravasation of blood constituents. The blood clot reestablishes heamostasis and provides extracellular matrix for cell migration. Platelets not only facilitate the formation of a haemostatic plug but also secrete several mediators of wound healing such as platelet – derived growth factor that attract and activate macrophages and fibroblasts. Numerous vasoactive mediators and chemotactic factors are generated by the coagulation and activated complement pathways, which help in recruiting inflammatory leukocytes to the site of injury.

With in the first 5-6 hrs after injury, neutrophils enter the wound. Infiltrating neutrophils cleanse the wounded area of foreign particles and bacteria and are then extruded with the eschar or phagocytosed by macrophages.

Monocytes then infiltrate the wound by 24-48 hrs in response to specific chemo attractants such as TGF-β. It becomes activated macrophages, which in turn releases growth factors such as platelet –

derived growth factor and vascular endothelial growth factor, which initiate the formation of granulation tissue. Macrophages bind to specific proteins of the extracellular matrix by their integrin receptors, an action that stimulates phagocytosis of microorganisms and fragments of extracellular matrix. Many important cytokines are released by the macrophages like CSF-1, TNF-α, TGF-α, IL-1, and other growth factors, which are necessary for the initiation and propagation of new tissue formation in wounds. Thus macrophages appear to have a pivotal role in the transition between inflammation and repair.

EPITHELIALIZATION:

During this period, there is also proliferation of epithelial cells at the epidermal-dermal junction, which migrate towards the midline reforming a thin epidermal layer under the surface clot. In sutured surgical wounds epithelial migration begins within the first 24hrs of injury and may be completed as early as 72hrs in healthy individuals.

Closure of the wound is not the only function of epithelial cells in the inflammatory phase. The development of techniques in molecular biology has led to unequivocal identification of many uninvolved cytokines. Keratinocytes have been shown to produce GM-CSF, TGF-α and fibroblast growth factor. IL-1 secreted by keratinocytes stimulates fibroblast proliferation and enchances the production of type I and II collagen mRNA and of an angiogenic factor. Thus they help to prepare and promote the next phase of wound healing.

Proliferative or granulation phase (2days-3weeks)

Various chemotactic, growth and activating factors produced in the inflammatory phase are concerned in the initiation and development of granulation tissue, which lasts for about 4-21 days after injury.

Granulation tissue comprises a loose matrix of fibrin, fibronectin, collagen and glycosaminaoglycans, particularly hyaluronic acid, containing macrophages, fibroblasts and in growing blood vessels. In incisional wounds during this phase the wound begins to gain tensile strength, although it is during this early period that wound dehiscence and evisceration most commonly occur.

Formation of granulation tissue

New stroma, often called granulation tissue, begins to invade the wound space approximately four days after injury. Numerous new capillaries endow the new stroma with its granular appearance. Macrophages, fibroblasts and blood vessels move into the wound space at the same time. The macrophages provide a continuing source of growth factors necessary to stimulate fibroplasias and angiogenesis; the fibroblasts produce the new extracellular matrix necessary to support cell in growth and blood vessels carry oxygen and nutrients necessary to sustain cell metabolism.

Growth factors especially platelet derived PDGF and TGF β stimulate fibroblasts to proliferate and migrate into the wound space. The structural molecules of the newly formed extracellular matrix, termed the 'provisional matrix', contribute to the formation of granulation tissue by providing a conduit for cell migration. These molecules include:

- **Fibrin**
- **Fibronectin**
- **Hyaluronic acid**

The appearance of fibronectin and the appropriate receptors that bind fibronectin, fibrin or both on fibroblasts appear to be the rate limiting step in the formation of granulation tissue. The fibroblasts are responsible for the synthesis, deposition and remodeling of the extracellular matrix. Conversely the extracellular matrix can have a feed back effects on the ability of fibroblasts to remodel.

Cell movement into a blood clot of cross – linked fibrin or into tightly woven extracellular matrix requires an active proteolytic system that can cleave a path for cell migration. A variety of fibroblast derived enzymes including plasiminogen activator and collagenases are potential candidates for this task.

After migrating into wound, fibroblasts commence the synthesis of extracellular matrix. The provisional matrix is gradually replaced with a collagenous matrix. Once an abundant collagen matrix has been deposited, the fibroblasts stop producing collagen and the fibroblast rich granulation tissue starts getting replaced by a relatively acellular scar.

Dysregulation of these processes occurs in fibrotic disorders such as keloid formation.

Neovascularization

The formation of new blood vessels is necessary to sustain the newly formed granulation tissue. Angiogenesis is a complex process

that relies on extracellular matrix in the wound bed as well as migration and mitogenie stimulation of endothelial cells.

Induction of angiogenesis has been attributed to molecules like TGF β, angiogensin, angiotropin, and vascular endothelial growth factor. Low oxygen tension and elevated lactic acid may also stimulate angiogenesis. Many of these molecules mentioned above appear to induce angiogenesis by stimulating the production of

a. **Basic fibroblast growth factor - active during first days of repair.**
b. **Vascular - Endothelial cell growth factor - critical during formation of granulation tissue on days 4 and day 7.**

Mechanism

Injury causes destruction of tissue and hypoxia. Angiogenesis factors such as fibroblast growth factor are immediately released from macrophages. Proteolytic enzymes released into the connective tissue degrade extracellular matrix proteins. Fragments of these proteins recruit peripheral blood monocytes to the site of injury, where they become activated macrophages and release angiogenesis factors. These factors stimulate endothelial cells to release phasminogen activator and procollagenases, which in concert get activated and digest basement membranes. The fragmentation of the basement membrane allows endothelial cells stimulated by angiogenesis factors to migrate and form new blood vessels at the injured site. . Once the wound is filled with granulation tissue, angiogenesis cases and many of the new blood vessels disintegrate as a result of apoptosis.

Mechanism of collagen formation and neovascularisation

Wound contraction or remodeling phase

During second week of healing, fibroblasts assume a myofibroblast phenotype characterized by large bundles of actin containing microfilaments disposed along the plasma membrane of cells and by cell – and cell – matrix linkage.

Granulation tissue begins to be remodeled and its vascularity decreases as the amount of collagen increases. Maturation of the scar occurs over the next few months and is characterized by further remodeling. Collagen produced from fibroblasts is initially laid down in a vertical manner; but gradually changes in orientation to align across the defect, leading to increased wound strength. In addition collagen type-III, which is initially laid down in the immature scar, is replaced with the more mature collagen type -I.

Collagen and wound healing

Collagen remodeling during the transition from granulation tissue to scar is dependent on continued synthesis and catabolism of collagen at a low rate. The degradation of collagen in the wound is controlled by several proteolytic enzymes termed matrix metalloproteinases. Various phases of wound repair rely on distinct combinations of matrix metalloproteinases and tissue inhibitors of metalloproteinases.

A healed skin will never achieve the tensile strength found previously in undamaged skin. Following injury, initial strength of skin is provided only by sutures and only 10% of original tensile strength is regained 1 week following injury. By third week, 29% of strength is

gained during which time fibrillar collagen has accumulated relatively rapidly and has been remodeled by contraction of the wound. Thereafter the rate at which wounds gain tensile strength is slow, reflecting a much slower rate of accumulation of collagen and, more important, collagen remodeling with formation of larger collagen bundles and an increase in number of intermolecular cross links. Nevertheless wounds never attain the same tensile strength as uninjured skin. A maximal strength, scar is only 70% as strong as normal skin.

METHODOLOGY

The present study was carried out at Department of surgery in Coimbatore Medical College Hospital , Coimbatore where 50 patients underwent clean elective surgeries (Appendisectomy, Hernia Repair, Thyroidectomy and Lipoma Excision) over a period of one year.

Study Design

A Randomised Clinical Trial

Source of Data

Patients with suspected clinically interval appendicitis, Inguinal Hernia, Solitary / Multi Nodular Goitre, who underwent Appendisectomy, Hernia repair, Thyroidectomy and Lipoma Excision respectively were selected for the study.

Sample Size

A total of 50 subjects were enrolled into the study.

Out of 50 patients, 25 underwent skin closure with "No Knot" subcuticular technique and the remaining 25 with standard subcuticular technique. All these patients were allotted to either group according to random number tables.

Inclusion Criteria

- **All patients undergoing elective clean surgeries**
- **Age group 18-65 years both inclusive**
- **Abdominal incision<10cms in size**

1. **Thyroidectomy**

2. **Lipoma Excision**
3. **Appendisectomy**
4. **Meshplasty**

Exclusion Criteria

- **Patients with**

1. **Anemia/Jaundice/Malnutrition**
2. **Diabetes mellitus/Tuberculosis**
3. **Immunocompromised states**
4. **Chronic immunotherapy/steroids**
5. **Emergency/contaminated surgeries**
6. **Patients developing post operative cough/ascites/distension**

Method of Collection of Data

A detailed history of each patient was obtained starting with history of presenting symptoms and any co-existing, co-morbid conditions like DM, HTN and Jaundice were ruled out.

A thorough physical examination was done to rule out the presence of pallor, Icterus or Cachexia. Pre-operatively all patients underwent following investigations;

- **CBC**
- **Urine Examination**
- **Blood Sugar, Blood Urea, Serum Creatinine**
- **LFT (whenever needed)**
- **Chest X-Ray, EGG(whenever needed)**

All cases were elective clean surgeries and the mode of anaesthesia was either general or spinal anaesthesia .they all received one mandatory dose of pre-operative parenteral antibiotic one hour prior to incision.

Painting was done with 10% povidine iodine solution for all cases.

Closure Technique

After performing surgeries the subcutaneous fat was closed with 2-0 chromic catgut interrupted sutures. subcuticular closure was done using polyglactin 910 suture material (2-0 to 5-0).

Standard Technique

Skin was approximated with standard subcuticular technique (i.e by putting knots at both the ends.)

No- Knot Technique

At the proximal end of the wound, approximately one centimeter away, the epidermal layer is entered with the suture needle and the tip is removed from the dermis. Informing the initial knot, a loop of suture needs to be created and this is accomplished by passing the tip of the needle through the dermis perpendicular to the initial exit point. The knot is formed y passing the whole suture needle through the loop in a direction that is towards the distal end of the wound. Tightening of the knot is achieved by holding the distal end of the suture (located outside the wound 1cm away from the proximal wound edge) and pulling the needle. This prevents slippage of the knot and allow it to be buried within the dermis. the wound edges are united in the conventional manner. Closure of the wound is concluded as follows the suture thread(attached to the base of the needle) is used as retractor and the needle is passed through the hole in the skin, through which it has just exited, to emerge out of the skin perpendicular to the last exit site. The technique is repeated at this exit point in the same manner as described, the needle again being at a different angle to the

second exit point. Both proximal and distal ends of the suture are cut in close approximation to the skin surface producing a symmetrically closed wound with no "dog ears", bulky knot or gaping wound edges.

For both the groups dry gauze dressing was given. Post operatively 5days of parenteral and oral antibiotics were given.

Ethical clearance has been obtained from our institution for conducting this study. Patients consent was obtained for all the cases.

On 3rd post operative day, the wound was evaluated for erythema, induration, , infection and wound gap.

Inflammation was defined as excessive redness and tenderness of incision site.

Infection was defined as presence of pus from wound or presence of erythema, edema. Pain or temperature, lasting beyond 7^{th} post operative day. Wound gaping was defined as presence of dehiscence, epidermal loss or loss of edge apposition on 7^{th} post operative day.

At 1 Month Follow Up

The wounds were evaluated according to HOLLANDER WOUND EVALUATION SCORE (HEWS) by an independent surgeon who was blinded to method of closure. The wound score addressed 6 clinical variables.

1. Absence of step off borders
2. Contour irregularities
3. Wound margin separation>2mm

4. Excessive distortion

5. Edge inversion

6. Overall cosmetic appearance

Each of these categories was graded on 0 or 1 patients scale. A total cosmetic score was obtained by addition of scores of 6 variables. A scores of 6 was considered optimal while 5 or less was sub optimal.

The wounds were also photographed and rated for cosmesis by VISUAL ANALOGUE SCORE. This cosmetic VAS is a 100 mm line with worst scar at 0 and the best scar at 100. Scar was rated by a senior surgeon blinded to the method of closure of wound.

0 Worst Scar	100 Best Scar

Using the line as a continuous entity the surgeon marked the patient's scar on the line. The score was then measured in millimeters from 0 to 100. The mean

VAS for each group was calculated.

RESULTS

A Total of 50 Patients who satisfied the selection criteria were included in the study. It was conducted at Department of surgery in Coimbatore Medical Collage Hospital, Coimbatore between DEC 2007 and JUNE 2009.

TABLE 1: AGE DISTRIBUTION

Age (years)	Knot	No Knot	Total
< 30 years	9 (36%)	7 (28%)	16 (32%)
31 – 40 years	7 (28%)	4 (16%)	11 (22%)
41 – 50 years	6 (24%)	9 (36%)	15 (30%)
> 50 years	3 (12%)	5 (20%)	8 (16%)
Total	25	25	50

Mean Age of patient in knot group was 35.4 years, 35.4 years (±9.66) and that of No Knot group was 44.3 years (± 13.9)

TABLE II : TYPE OF OPERATION

Procedure	Knot (Control)	No Knot (Study)	Total
Appendisectomy	7 (25%)	5 (20%)	15 (30%)
Hernia repair	8 (32%)	8 (32%)	16 (32%)
Thyroidectomy	8 (32%)	10 (40%)	18 (36%)
Lipoma Excision	2 (8%)	2 (8%)	4 (8%)
Total	25	25	50

15 (30%) underwent Appendisectomy for complaints of Appendicitis. 16 (32%) underwent Hernia repair for Indirect / Direct Inguinal Hernia repair, Thyroidectomy for Solitary / Multi Nodular Goiter, Excision of Lipoma.

TABLE III: WOUND COMPLICATIONS

Complications	Knot	No Knot	Total
Infection	4 (16%)	3 (12%)	7
Wound Gap	5 (20%)	2 (8%)	8
Total	10	5	15

KNOT GROUP

4 patients (16%) had post operative infection in the form of purulent discharge on 5th POD. 5 patients (20%) developed wound gaping.

NO KNOT GROUP

3 patients (12%) developed wound infection and only 2 patients (8%) developed wound gaping.

TABLE IV: COMPARISON OF INFECTION IN THE TWO GROUPS

Complication	Knot	No Knot
Infection	4 (16%)	3 (12%)

P = 0.38%

On calculating P value, it came as insignificant i.e. no significant difference was found in infection in both the groups.

TABLE V: COMPARISION OF WOUND GAPING IN THE TWO GROUPS

Complication	Knot	No Knot
Wound gaping	5 (20%)	2 (8%)

P = 0.052

Although the 'No Knot' group had lesser number of Wound Gaping, but it was statistically insignificant (p=0.052)

TABLE VI: COMPARISON OF HOSPITAL STAY IN THE TWO GROUPS

	Knot	No Knot
Hospital stay (in day)	7.3 (±3)	6.4 (±2.5)

Using Mann - Whitney methods of statistical significance, P value was > 0.05 (P=0.7154). No statistical difference was found between two groups

TABLE VII: COSMETIC EVALUATION

Cosmetic outcome	Knot	No Knot	P Value
VAS	66.46 (±17.66)	71.6 (± 10.2)	0.0136
HWES	4.32 (± 1.28)	5.02 (± 0.88)	0.0001

Patients were cosmetically evaluated at 1 month post operative, 4 patients were lost to follow up.

- **Average VAS of patients in Knot group was 64.6 and 71.6 in no knot group**
- **Average HWES of patients in knot group was 4.32 and 5.02 in No Knot group**
- **P value was highly significant in both the scores.**

TABLE VII: WOUND COMPLIATIONS WITH RESPECT TO SEX OF PATIENTS

	'P' Value	
	Knot	No Knot
Infection	0.83	0.99
Wound gaping	0.38	0.57

No significant difference was noted in infection and wound gaping with regard to the sex of the patient.

DISCUSSION

For the surgeon, a scar may be the only trademark of the surgical procedure performed, as Fitz Gibbon has stated. "By your scars you will be judged" (Fitz Gibbon 1968)

There are many factors that affect the cosmetic outcome of scars

The following factors are important in comparing the various methods which are available:

- **Incidence of Complication**
- **Cosmetic Results**
- **Patient comfort and acceptability**
- **Ease of post operative wound care (dressing, wound inspection), ease of dealing with complications occur, and ease of removal.**

The running subcuticular suture is valuable in areas in which the tension is minimal, the dead space has been eliminated, and the best possible cosmetic result is desired. Because the epidermis is penetrated only at the beginning and end of the suture line, the subcuticular suture effectively eliminates the risk of crosshatching. The suture does not provide significant wound strength, although it does precisely approximate the wound edges. Therefore, the running subcuticular suture is bet reserved for wounds in which the tension has been eliminated with deep sutures, and the wound edges are of approximately equal thickness.

In our study 50 patients underwent clean elective surgeries (Appendisectomy, Hernia repair, Thyroidectomy and Lipoma Excision). Out of

50 , 25 underwent closure of skin with "No Knot" subcuticular technique while remaining 25 had their skin closed with standard "Knot" technique.

The comparison of the two groups was done in relation to:

1. **Post Operative wound complications (Infection and wound Gaping)**
2. **Cosmetic Outcome**
3. **Hospital stay**

Mean Age of patient in know group was 35.4 years, (+/-9.66) and that of No. Knot group was 44.3 years (+ /-13.9).

15 (30%) underwent Appendisectomy for complaints of Appendicitis. 16 (32%) underwent Hernia repair for Indirect / Direct Inguinal Hernia repair, 18(36%) underwent Thyroidectomy for Solitary / Multi Nodular Goiter, 4 (8%) underwent Excision for Lipoma.

WOUND COMPLICATIONS

The primary objective of the study was to measure the incidence of post operative wound complications.

Wound complications included:

- **Infection**
- **Wound Gap**

Infection of the wound is the presence of serosanguinous discharges or frank pus. In the "KNOT" group 4 patients (16%) had post operative infection

in the form of purulent discharge on 5th POD. In the "NO KNOT" group 03 (12%) patients developed wound infections.

On calculating P value, it came as insignificant i.e. no significant difference was found in infection in both the groups (p>.05).

All patients with wound infection had their discharge sent for culture and sensitivity and antibiotics were instituted as per the report. Secondary suturing was done in 2 patients in the "KNOT" group. In the other 2 patients wounds healed with regular dressings. In the "NO KNOT" group secondary was required in 1 patients and the rest wounds healed with regular dressings.

5 patients (20%) developed wound gaping in the "KNOT" group and in comparison to that only 2 patients (8%) developed wound gaping in the "NO KNCT" group.

Even though the wound gaping rate was less in the "NO KNOT group, it was found to be statistically insignificant (p>.05).

In a study conducted by Murtha, Kaplan, Andrew et all it was proved that Suture knots may be a nidus for infection and they may extrude through skin after surgery.41

EJ van Rijssel, R Brand, C Admiral concluded in their study that addition of extra throws to the knot enlarged the knot body by a factor of 1.5, which is deleterious to optimal wound healing.

DURATION OF HOSPITAL STAY

The difference in the two groups was found to be statistically insignificant (p>.05).

Average stay in the "KNOT" group was 7.3 days. If wound complications occurred, the patients required a longer stay.

Average stay in the "NO KNOT" group was 6.4 days. Though it was only slightly less than as compared to "KNOT" group, it was not statistically significant.

COSMESIS

All the patients were followed up 1 month after discharge for evaluation of scar. A senior surgeon blinded to the method of closure of subcutaneous technique evaluated it.

4 patients were lost to follow up. Cosmetic outcome for the remaining patients were evaluated based on.

Visual Analogue Score

VAS obtained by analysis of month post operative photographs, revealed cosmetic results between the two groups.

- **Average VAS of patients in knot group was 6.46 and 71.6 No Knot group.**
- **Average HWES of patients in knot group was 4.32 and 5.02 in No knot group.**
- **P value was highly significant in both the scores. ($p<05$)**

In a study conducted by Ulrich Hohenleutner et al, cosmetic results were excellent to good in 78.5% satisfactory in 19.5% and poor in 2% Single additional superficial sutures had to be placed in only 14.7% Suture marks were

absent. As opposed to our study hypertrophic scarring was significantly more frequent in scars sutured with polyglactine than in scars sutured with polydioxanone in their study.50

D Singh Langer also found a cosmetically better scarring with his "NO KNOT" subcuticular technique.19

LIMITATIONS

- **Sample size was small**
- **Long term follow up of at least 1 year is required for cosmetic evaluation, which was possible only 2 patients in our study.**

This method for creating a starting knot for subcuticular suture is easy to master and can be used by all grades of surgeons in all specialties, in particular minimally invasive and pediatric surgeons who wish to close small skin wounds. The subcuticular suture technique here is secure, in that it keeps the wound edges together, and minimize the use of additional methods to close the skin.

SUMMARY

A total of 50 patients who satisfied the selection criteria were included in the study.

Equal number of 25 cases were randomly selected and divided in both the groups.

Mean age of patient in knot group was 35.4 years, 35.4 years (+/-9.66) and that of No knot group was 44.3 years (+/_13.9).

15 (30%) underwent Appendisectomy for complaints of Appendicitis. 16 (32%) underwent hernia repair for Indirect / Direct Inguinal Hernia repair, 18 (36%) Thyroidectomy for Solitary / Multi Nodular Goitre, 4 (8%) Excision of Lipoma.

In the knot group, 4 patients (16%) had post operative infection in the form of purulent discharge on 5th POD. 5 patients (20%) developed wound gaping.

In the No knot group, 3 patients (12%) developed wound infections and only 2 patients (8%) developed wound gaping.

On calculating P value, it came as insignificant i.e. no significant difference was found in infection in both the groups.

The 'No Knot' group had lesser number of wound gapings as compared to knot group but it was statistically insignificant (p>0.052).

Patients were cosmetically evaluated at 1 month post operative, 4 patients were lost to follow up.

- **Average VAS of patients in knot group was 6.46 and 71.6 in No knot group.**
- **Average HWES of patients in knot group was 4.32 and 5.02 in No knot group.**
- **P value was highly significant in both the scores.**

Thus subcuticular skin closure using No knot technique was found to be associated with low incidence of wound gaping and a cosmetically acceptable scar as compared to standard subcuticular suturing technique.

CONCLUSION

Cosmesis is an important aspect in this day and age. A cosmetic scar not only gives patient satisfaction but also mental ease to the surgeon.

Sepsis is a great hazard in any abdominal surgery as it can lead to disastrous consequences.

Suture knots present several disadvantages in wound closure, because they are tedious to tie and place ischaemic demands on the issue. Bulky knots may be a nidus for infection and they may extrude through skin weeks after surgery.

In our study comparison was done between putting a "KNOT" and a new technique of "NO KNOT" subcuticular suturing. We found that

- **Incidence of post operative wound infection was slightly less (12%) in the No Knot group.**

- **Incidence of wound gaping (8%) was less in No Knot group and was statistically insignificant.**

- **The No Knot group provided a better cosmesis than the other group ($p<0.05$).**

Hence we conclude that "NO KNOT" subcuticular technique is associated with a low incidence of wound gaping and gives a cosmetically better scar and thus recommend its use in closing skin by subcuticular technique.

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Annexure I – Photographs

Photograph I: Prior to applying the No Knot subcuticular technique

Photograph II: Entry of the Stitch

Photograph III: Stage I of Locking of stitch

Photograph IV: Stage II Locking of stitch

Photograph V: Regular subcuticular stitches

Photograph VI: Exit through the wound

Photograph VII: Exit perpendicular to the previous stitch

PhotographVIII: Wound appearance applying stitches

Photograph IX: Flush cutting of the suture

Photograph X: Immediate post operative appearance

ANNEXURE II – CONSENT FORM

CONSENT FOR PARTICIPATION IN RESEARCH STUDY OF " COMPARISON OF NO KNOT VERSUS KNOT SUBCUTICULAR TECHNIQE" AT CMCH HOSPITAL AND COIMBATORE BETWEEN DEC 2007 AND JUNE 2009.

Principal Investigator – Dr. B.K.SRINIVASAN

You are being asked to a subject in a research study of COMPARISON OF NO KNOT VERSUS KNOT SUBCUTICULAR TECHINIQE" at CMCH Hospital COIMBATORE between June 2008 and June 2009 conducted by Dr. B.K.Srinivasan , post Graduate student in department of General Surgery at Coimbatore Medical College, Coimbatore, Dr. M.G.R. Medical University, Tamilnadu.

Your have been asked to participate in this research because retention of subcuticular stitch has been performed using a number of techniques. These techniques have been difficult to master and associated with problems of bulky knot and wound gaping. The new study aims to reduce the above problems and minimize wound gaping.

Your participation in this research is your voluntary decision whether or not to participate will not affect your current or future relationship with department of surgery , CMCH , Coimbatore. If you decide to participate, you are free to withdraw at any time without affecting the relationship.

PROCEDURES INVOLVED

If you agree to be in this research we would ask you about the present and past history. Any history of anaemia, jaundice. Diabetes Mellitus, Tuberculosis, malignancy or chemotherapy would be evaluated. Investigations will be collected. Based on randomization, the study and control group will be divided and studied.

RISK AND BENEFITS

There is no risk involved in the procedure. The benefit would be in the form of reduced wound gaping and better cosmetic result.

During the course of study, you will be informed of any significant new findings or side effects resulting form participation in the research.

PRIVERY AND CONFIDENTIALITY

The only people who will know that you are a research subject are members of the research team. No information about you or provided by you during the research will be disclosed to others, without your written permission except,

1. **If necessary to protect your rights and welfare.**
2. **If required by law.**

When the results of the research are published or discussed in conferences no information will be disclosed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or if required by law.

In the event of injury related to this research study, treatment will be made available through CMCH Hospital Coimbatore. There is no compensation or payment for such medical treatment form the centre by law. If you are injured, you may contact Dr. B.K.Srinivasan and Dr. Tamilselvan at Department of Surgery, CMCH Coimbatore.

You will not be paid/offered any free gifts for participation in the research. There will not be any remuneration for participating in the

research, you will not be reimbursed for any expenses, such as bus/train travel/companion/assistant.

If you volunteer to be in this study, you may withdraw any time or may refuse to answer any questions.

STATEMENT OF CONSENT

To voluntarily agree to take part in this study, I must sign on the line below. If I choose to take part in this study. I may withdraw at anytime. I am not giving up any legal rights by signing this from my signature below indicates that I have read or had read to me, this entire consent from, including the risks benefits and benefits and have had all my questions answered. I will be given a copy of this consent form.

Name:_____
Signature of authorized representative
Name:
Relation to the subject
Signature of Witness
Name:
Signature of Investigator
Name:

ANNEXURE III – PROFORMA

Group : Standard / New Technique

Name: IP.No:

Age : DOA :

Sex : DOD :

Address

Diagnosis

Associated medical illness

	Present	Absent
Anaemia		
Jaundince		
Diabetes Mellitus		
Tuberculosis		
Malignancy		
Steroids		

Investigations

- **Complete blood count**
- **Random blood sugar**
- **Blood urea**
- **S. Creatinine**
- **Liver Functions Tests**
- **Chest X-ray**
- **ECG**

Operative Procedure:

Post op **Cough**

Distention

Ascites

- **Wound Gaping 07th post of day**

Cosmetic evaluation (at 1 months)

Visual analogue score

Hollander wound evaluation score

- **Absence of step off borders**
- **Coutour irregularities**
- **Wound margin separation >2mm**
- **Excessive distortion**
- **Edge inversion**
- **Overall cosmetic evaluation**

Total Score = /6

-
- **Type of Technique**
- **Wound infection**
- **Wound gaping**
- **Cosmesis**

Annexure III – Master Chart

SI NO	IP. NO	AGE (IN YEARS)	SEX	OPERATIVE PROCEDURE	SKIN CLOSURE	INFECTION	WOUND GAPING	HOSPITAL STAY IN DAYS	VAS	HWES
1.	61253	28	M	A	KNOT	-		6	82	5.50
2.	62873	39	M	H	KNOT	_		5	80	5.50
3.	62765	26	F	A	KNOT	_		7	LOST	LOST
4.	63124	31	M	H	KNOT	Y	+	9	41	2.00
5.	63335	24	M	A	KNOT	-		8	76	5.50
6.	65827	33	F	T	KNOT	-		6	76	5.50
7.	61724	29	F	A	KNOT	-		8	80	4.50
8.	72982	42	M	H	KNOT	-		10	80	4.50
9.	71729	37	F	LE	KNOT	-		3	LOST	5.00
10.	71883	59	F	T	KNOT	-		5	76	5.00
11.	61625	29	M	A	KNOT	Y	+	14	43	1.5O
12.	63943	33	M	T	KNOT	-		6	76	4.50
13.	60092	30	F	T	KNOT	-		7	78	4.50
14.	62028	44	M	H	KNOT	-		9	66	5.00
15.	62038	67	F	T	KNOT	-	-	8	47	1.50
16.	69627	26	F	H	KNOT	-		6	63	5.00
17.	73884	45	F	T	KNOT	-		14	72	4.5O
18.	72096	28	F	A	KNOT	Y	+	12	45	2.50

19.	76643	49	M	H	KNOT	_		8	71	5.00
20.	71094	63	F	LE	KNOT	_		3	68	5.00
21.	61098	37	M	H	KNOT	Y	+	11	48	2.00
22.	61043	46	F	T	KNOT	-		8	76	4.50
23.	63219	38	F	A	KNOT	_		10	73	5.00
24.	63373	44	F	T	KNOT	_		9	73	5.00
25	66342	30	M	H	KNOT	_	+	10	46	3.50

SI NO	IP.NO	AGE IN YEARS	SEX	OPERATIVE PROCEDURE	SKIN CLOSURE	INFECTION	WOUND GAPING	HOSPITAL STAY IN DAYS	VAS	HWES
1	72711	19	F	A	NO KNOT	_	_	6	74	4.50
2	75478	63	F	T	NOKNOT	_	_	6	76	5.50
3	82361	43	F	T	NOKNOT	_	_	8	78	4.50
4	88127	25	M	A	NOKNOT	_	_	10	82	5.00
5	74335	45	M	T	NOKNOT	_	_	7	80	4.50
6	62539	33	F	A	NOKNOT	Y	+	12	50	1.50
7	63536	17	F	H	NOKNKOT	_	_	6	68	4.50
8	54336	44	M	T	NOKNOT	_	_	8	70	5.00
9	66598	23	M	H	NOKNOT	_	_	8	66	4.00
10	56000	71	F	T	NOKNOT	_	_	8	77	6.00
11	72300	37	F	T	NOKNOT	_	-	6	82	5.00
12	68232	24	M	H	NOKNOT	_	_	5	83	5.50
13	80533	47	F	LE	NOKNOT	_	_	3	50	5.50
14	74653	69	F	T	NOKNOT	_	_	4	75	5.50
15	70110	29	M	H	NOKNOT	_	_	6	80	5.00
16	75363	59	F	T	NOKNOT	_	_	6	73	5.50

17	81279	44	F	LE	NOKNOT	Y	_	10	55	2.50
18	75133	43	M	H	NOKNOT	_	_	6	73	5.50
19	63300	38	M	H	NOKNOT	_	_	6	84	6.00
20	60285	27	F	A	NOKNOT	_	_	4	66	4.50
21	71756	46	F	T	NOKNOT	_	_	4	76	4.50
22	63538	46	F	T	NOKNOT	Y	+	14	45	3.50
23	70765	33	M	A	NOKNOT	_	_	8	85	5.00
24	54387	51	M	H	NOKNOT	_	_	6	85	5.00
25	45628	41	M	H	NOKNOT	_	_	8	72	5.50

ANNEXURE – IV

KEY TO MASTER CHART

A – Appendisectomy

H – Hernia Repair

T – Thyroidectomy

LE - Lipoma Excision